

WHAT IS CLAIMED IS:

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1. A method for embedding digital watermark data in digital data contents, said method comprising the steps of:

10 receiving said digital data contents and said digital watermark data;

dividing said digital data contents into block data;

obtaining a frequency coefficient of said block data;

15 obtaining a complexity of said block data;

obtaining an amount of transformation of said frequency coefficient from said complexity and said digital watermark data by using a quantization width;

20 embedding said digital watermark data in said digital data contents by transforming said frequency coefficient by said amount; and

generating watermarked digital data contents.

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30 2. The method as claimed in claim 1, said step of obtaining said complexity of said block data comprising the steps of:

transforming said block data, by applying a wavelet transform, into coefficients of said wavelet transform, and

35 obtaining said complexity on the basis of the number of high frequency coefficients in said coefficients of said wavelet transform, each of said

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obtaining a binary distribution function $F(x)$ which represents a probability that a number x of '1' bits or '0' bits are included in a bit sequence which is read at random from digital data contents, said binary distribution function $F(x)$ being obtained by using a probability q of reading '1' or '0' in said bit sequence and a repeating number of embedding each bit of digital watermark data;

reading an i th digital watermark sequence of said digital watermark data from a digital watermark area of said digital data contents;

calculating the number k_i of '1' or '0' included in said digital watermark sequence;

calculating a probability $F(k_i)$ by using said binary distribution function $F(x)$; and

reconstituting '1' or '0' from i th digital watermark data w_i if $F(k_i) > \alpha$, reconstituting '0' or '1' from i th digital watermark data w_i if $1-F(k_i) > \alpha$, and determining that there is no watermark data or the presence is unknown if both of $F(k_i) > \alpha$ and $1-F(k_i) > \alpha$ are not satisfied.

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227. The method as claimed in claim 26, further comprising the steps of:

outputting $F(k_i)$ as reliability if said reconstituted digital watermark data w_i is '1'; and

outputting $1-F(k_i)$ as the reliability if said reconstituted digital watermark data w_i is '0'.

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28. The method as claimed in claim 25,

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further comprising the steps of:

determining a threshold α of reliability of digital watermark data which is read;

obtaining a binary distribution function
5 F(x) which represents a probability that a number x of '1' bits or '0' bits are included in a bit sequence which is read at random from digital data contents, said binary distribution function F(x) being obtained by using a probability q of reading
10 '1' or '0' in said bit sequence and a repeating number of embedding each bit of digital watermark data;

reading an ith digital watermark sequence of said digital watermark data from a digital
15 watermark area of said digital data contents;

checking whether a probability that said digital watermark sequence is digital watermark data exceeds said threshold α by using said binary distribution function F(x); and

20 reconstituting digital watermark data from said digital watermark sequence by using majority decision processing if said probability exceeds α , and determining that there is no watermark data or the presence is unknown if said probability does not
25 exceed α .

30 4₂₈. The method as claimed in claim 3₂₈, further comprising a step of outputting said probability that said digital watermark sequence is digital watermark data.

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in said ith digital watermark sequence and a central value $q \times t$ of a binary distribution;

reconstituting digital watermark data by performing majority decision processing for said ith digital watermark sequence if said value is equal to or less than x_0 or equal to or more than x_1 ; and

determining that there is no digital watermark data or the presence is unknown if said value is not equal to or less than x_0 or equal to or more than x_1 .

33. The method as claimed in claim 32, further comprising the steps of:

calculating a value of said binary distribution function $F(z)$, z being said mean value obtained from the number of '0' or '1' included in said ith digital watermark sequence and said central value $q \times t$; and

outputting said value of $F(z)$ as reliability of digital watermark data.

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34. An apparatus for reading digital watermark data embedded in digital data contents, said apparatus comprising:

means for receiving said digital data contents;

means for reading a bit sequence from said digital data contents;

means for calculating a probability of reading a bit '1' or a bit '0' in said bit sequence by using a test method on the basis of binary

5 ¹⁰~~36~~ The apparatus as claimed in claim ⁹~~35~~,
further comprising:

means for outputting $F(k_i)$ as reliability
if said reconstituted digital watermark data w_i is
'1'; and

10 means for outputting $1-F(k_i)$ as
reliability if said reconstituted digital watermark
data w_i is '0'.

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37. The apparatus as claimed in claim 34,
further comprising:

20 means for obtaining a binary distribution
function $F(x)$ which represents a probability that a
number x of '1' bits or '0' bits are included in a
bit sequence which is read at random from digital
data contents, said binary distribution function
25 $F(x)$ being obtained by using a probability q of
reading '1' or '0' in said bit sequence and a
repeating number of embedding each bit of digital
watermark data;

30 means for reading an i th digital watermark
sequence of said digital watermark data from a
digital watermark area of said digital data
contents;

35 means for checking whether a probability
that said digital watermark sequence is digital
watermark data exceeds said threshold α by using
said binary distribution function $F(x)$, α being a
threshold of reliability of digital watermark data
which is read; and

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means for reconstituting and generating digital watermark data from said digital watermark sequence by using majority decision processing if said probability exceeds α , and, determining that there is no watermark data or the presence is unknown if said probability does not exceed α .

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1238. The apparatus as claimed in claim 37, further comprising means for outputting said probability that said digital watermark sequence is digital watermark data.

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39. The apparatus as claimed in claim 34, if a data sequence which is embedded as said digital watermark data is modulated by a pseudo-random sequence, said apparatus further comprising:

means for demodulating said bit sequence by said pseudo-random sequence; and

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means for reconstituting digital watermark data from said demodulated bit sequence.

30

40. The apparatus as claimed in claim 34, if a data sequence which is embedded as said digital watermark data is modulated by a pseudo-random sequence, said apparatus further comprising:

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means for obtaining a binary distribution function $F(x)$ which represents a probability that a number x of '1' bits or '0' bits are included in a

1642. The apparatus as claimed in claim 41, further comprising:

means for calculating a value of said binary distribution function $F(z)$, z being said mean value obtained from the number of '0' or '1' included in said i th digital watermark sequence and said central value $q \times t$; and

means for outputting said value of $F(z)$ as reliability of digital watermark data.

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43. An integrated circuit for reading digital watermark data embedded in digital data contents, said integrated circuit comprising:

means for receiving said digital data contents;

means for reading a bit sequence from said digital data contents;

means for calculating a probability of reading a bit '1' or a bit '0' in said bit sequence by using a test method on the basis of binary distribution;

means for determining the presence or absence of digital watermark data according to said probability; and

means for reconstituting and generating said digital watermark data from said bit sequence.

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44. The integrated circuit as claimed in claim 43, further comprising:

means for obtaining a binary distribution function $F(x)$ which represents a probability that a

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number x of '1' bits or '0' bits are included in a bit sequence which is read at random from digital data contents, said binary distribution function $F(x)$ being obtained by using a probability q of reading '1' or '0' in said bit sequence and a repeating number of embedding each bit of digital watermark data;

means for reading an i th digital watermark sequence of said digital watermark data from a digital watermark area of said digital data contents;

means for calculating the number k_i of '1' or '0' included in said digital watermark sequence;

means for calculating a probability $F(k_i)$ by using said binary distribution function $F(x)$; and

means for reconstituting '1' or '0' from i th digital watermark data w_i if $F(k_i) > \alpha$, reconstituting '0' or '1' from i th digital watermark data w_i if $1-F(k_i) > \alpha$, and determining that there is no watermark data or the presence is unknown if both of $F(k_i) > \alpha$ and $1-F(k_i) > \alpha$ are not satisfied, α being a threshold of reliability of digital watermark data which is read.

17 18 45. The integrated circuit as claimed in claim 44, further comprising:

means for outputting $F(k_i)$ as reliability if said reconstituted digital watermark data w_i is '1'; and

means for outputting $1-F(k_i)$ as reliability if said reconstituted digital watermark data w_i is '0'.

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46. The integrated circuit as claimed in claim 43, further comprising:

5 means for obtaining a binary distribution function $F(x)$ which represents a probability that a number of x of '1' bits or '0' bits are included in a bit sequence which is read at random from digital data contents, said binary distribution function
10 $F(x)$ being obtained by using a probability q of reading '1' or '0' in said bit sequence and a repeating number of embedding each bit of digital watermark data;

means for reading an i th digital watermark
15 sequence of said digital watermark data from a digital watermark area of said digital data contents;

means for checking whether a probability that said digital watermark sequence is digital
20 watermark data exceeds said threshold α by using said binary distribution function $F(x)$, α being a threshold of reliability of digital watermark data which is read; and

means for reconstituting and generating
25 digital watermark data from said digital watermark sequence by using majority decision processing if said probability exceeds α , and, determining that there is no watermark data or the presence is unknown if said probability does not exceed α .

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35 claim ¹⁹~~46~~²⁰ 47. The integrated circuit as claimed in claim ~~46~~, further comprising means for outputting said probability that said digital watermark sequence is digital watermark data.

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watermark sequence by said pseudo-random sequence;
means for assigning $1/2$ to said
probability q ;

means for obtaining x_0 or x_1 which
5 satisfies $0 \leq F(x=x_0) \leq 1-\alpha$ or $\alpha \leq F(x=x_1) \leq 1$, α being a
threshold of reliability of digital watermark data
which is read;

means for determining whether a value is
equal to or less than x_0 or equal to or more than x_1 ,
10 said value being a mean value of absolute values of
a difference between the number of '0' or '1'
included in said i th digital watermark sequence and
a central value $q \times t$ of a binary distribution;

means for reconstituting digital watermark
15 data by performing majority decision processing for
said i th digital watermark sequence if said value is
equal to or less than x_0 or equal to or more than
 x_1 ; and

means for determining that there is no
20 digital watermark data or the presence is unknown if
said value is not equal to or less than x_0 or equal
to or more than x_1 .

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^{23 24} 51. The integrated circuit as claimed in
claim 50, further comprising:

means for calculating a value of said
30 binary distribution function $F(z)$, z being said mean
value obtained from the number of '0' or '1'
included in said i th digital watermark sequence and
said central value $q \times t$; and

means for outputting said value of $F(z)$ as
35 reliability of digital watermark data.

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data from a digital watermark area of said digital data contents;

5 program code means for calculating the number k_i of '1' or '0' included in said digital watermark sequence; and

program code means for calculating a probability $F(k_i)$ by using said binary distribution function $F(x)$;

10 program code means for reconstituting '1' or '0' from i th digital watermark data w_i if $F(k_i) > \alpha$, reconstituting '0' or '1' from i th digital watermark data w_i if $1-F(k_i) > \alpha$, and, determining that there is no watermark data or the presence is unknown if both of $F(k_i) > \alpha$ and $1-F(k_i) > \alpha$ are
15 not satisfied, α being a threshold of reliability of digital watermark data which is read.

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54. The computer readable medium as claimed in claim ²⁵53, further comprising:

25 program code means for outputting $F(k_i)$ as reliability if said reconstituted digital watermark data w_i is '1'; and

program code means for outputting $1-F(k_i)$ as reliability if said reconstituted digital watermark data w_i is '0'.

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55. The computer readable medium as claimed in claim 52, further comprising:

program code means for obtaining a binary distribution function $F(x)$ which represents a probability that a number x of '1' bits or '0' bits

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are included in a bit sequence which is read at random from digital data contents, said binary distribution function $F(x)$ being obtained by using a probability q of reading '1' or '0' in said bit sequence and a repeating number of embedding each bit of digital watermark data;

program code means for reading an i th digital watermark sequence of said digital watermark data from a digital watermark area of said digital data contents;

program code means for checking whether a probability that said digital watermark sequence is digital watermark data exceeds said threshold α by using said binary distribution function $F(x)$, α being a threshold of reliability of digital watermark data which is read; and

program code means for reconstituting and generating digital watermark data from said digital watermark sequence by using majority decision processing if said probability exceeds α , and determining that there is no watermark data or the presence is unknown if said probability does not exceed α .

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56. The computer readable medium as claimed in claim 55, further comprising program code means for outputting said probability that said digital watermark sequence is digital watermark data as reliability of said reconstituted digital watermark data.

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program code means for assigning $1/2$ to said probability q ;

program code means for obtaining x_0 or x_1 which satisfies $0 \leq F(x=x_0) \leq 1-\alpha$ or $\alpha \leq F(x=x_1) \leq 1$, α being a threshold of reliability of digital watermark data which is read;

program code means for determining whether a value is equal to or less than x_0 or equal to or more than x_1 , said value being a mean value of absolute values of a difference between the number of '0' or '1' included in said i th digital watermark sequence and a central value $q \times t$ of a binary distribution;

program code means for reconstituting digital watermark data by performing majority decision processing for said i th digital watermark sequence if said value is equal to or less than x_0 or equal to or more than x_1 ; and

program code means for determining that there is no digital watermark data or the presence is unknown if said value is not equal to or less than x_0 or equal to or more than x_1 .

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A 50. The computer readable medium as claimed in claim 31, further comprising:

program code means for calculating a value of said binary distribution function $F(z)$, z being said mean value obtained from the number of '0' or '1' included in said i th digital watermark sequence and said central value $q \times t$; and

program code means for outputting said value of $F(z)$ as reliability of digital watermark data.

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57. The computer readable medium as claimed in claim 52, if a data sequence which is embedded as said digital watermark data is modulated by a pseudo-random sequence, said computer readable medium further comprising:

program code means for demodulating said bit sequence by said pseudo-random sequence; and

program code means for reconstituting digital watermark data from said demodulated bit sequence.

58. The computer readable medium as claimed in claim 52, if data sequence which is embedded as said digital watermark data is modulated by a pseudo-random sequence, said computer readable medium further comprising:

program code means for obtaining a binary distribution function $F(x)$ which represents a probability that a number x of '1' bits or '0' bits are included in a bit sequence which is read at random from digital data contents, said binary distribution function $F(x)$ being obtained by using a probability q of reading '1' or '0' in said bit sequence and a repeating number of embedding each bit of digital watermark data;

program code means for reading an i th digital watermark sequence of said digital watermark data from a digital watermark area of said digital data contents;

program code means for demodulating said digital watermark sequence by said pseudo-random sequence;

program code means for assigning $1/2$ to said probability q ;

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program code means for obtaining a maximum number x_0 which satisfies $0 \leq F(x=x_0) \leq 1-\alpha$ and a minimum number x_1 which satisfies $\alpha \leq F(x=x_1) \leq 1$, α being a threshold of reliability of digital

5 watermark data which is read;

program code means for obtaining the number k_i of '1' or '0' included in said i th digital watermark sequence; and

10 program code means for reconstituting i th digital watermark data w_i as '0' or '1' if $k_i \leq x_0$, and reconstituting said i th digital watermark data w_i as '1' or '0' if $k_i \geq x_1$.

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59. The computer readable medium as claimed in claim 52, if a data sequence which is embedded as said digital watermark data is modulated by a pseudo-random sequence, said computer readable medium further comprising:

20 program code means for obtaining a binary distribution function $F(x)$ which represents a probability that a number x of '1' bits or '0' bits are included in a bit sequence which is read at random from digital data contents, said binary distribution function $F(x)$ being obtained by using a probability q of reading '1' or '0' in said bit sequence and a repeating number t of embedding each

25 bit of digital watermark data;

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program code means for reading an i th digital watermark sequence of said digital watermark data from a digital watermark area of said digital data contents;

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program code means for demodulating said digital watermark sequence by said pseudo-random sequence;

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52. A computer readable medium storing
program code for causing a computer system to read
5 digital watermark data embedded in digital data
contents, said computer readable medium comprising:

program code means for receiving said
digital data contents;

10 program code means for reading a bit
sequence from said digital data contents;

program code means for calculating a
probability of reading a bit '1' or a bit '0' in
said bit sequence by using a test method on the
basis of binary distribution;

15 program code means for determining the
presence or absence of digital watermark data
according to said probability; and

20 program code means for reconstituting and
generating said digital watermark data from said bit
sequence.

53. The computer readable medium as
claimed in claim 52, further comprising:

25 program code means for obtaining a binary
distribution function $F(x)$ which represents a
probability that a number x of '1' bits or '0' bits
30 are included in a bit sequence which is read at
random from digital data contents, said binary
distribution function $F(x)$ being obtained by using a
probability q of reading '1' or '0' in said bit
sequence and a repeating number of embedding each
35 bit of digital watermark data;

program code means for reading an i th
digital watermark sequence of said digital watermark

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means for assigning $1/2$ to said probability q ;

means for obtaining a maximum number x_0 which satisfies $0 \leq F(x=x_0) \leq 1-\alpha$ and a minimum number x_1 which satisfies $\alpha \leq F(x=x_1) \leq 1$, α being a threshold of reliability of digital watermark data which is read; and

means for obtaining the number k_i of '1' or '0' included in said i th digital watermark sequence;

means for reconstituting i th digital watermark data w_i as '0' or '1' if $k_i \leq x_0$, and, reconstituting said i th digital watermark data w_i as '1' or '0' if $k_i \geq x_1$.

50. The integrated circuit as claimed in claim 43, if a data sequence which is embedded as said digital watermark data is modulated by a pseudo-random sequence, said integrated circuit further comprising:

means for obtaining a binary distribution function $F(x)$ which represents a probability that a number x of '1' bits or '0' bits are included in a bit sequence which is read at random from digital data contents, said binary distribution function $F(x)$ being obtained by using a probability q of reading '1' or '0' in said bit sequence and a repeating number t of embedding each bit of digital watermark data;

means for reading an i th digital watermark sequence of said digital watermark data from a digital watermark area of said digital data contents;

means for demodulating said digital

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48. The integrated circuit as claimed in claim 43, if a data sequence which is embedded as said digital watermark data is modulated by a pseudo-random sequence, said integrated circuit further comprising:

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means for demodulating said bit sequence by said pseudo-random sequence; and

means for reconstituting digital watermark data from said demodulated bit sequence.

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49. The integrated circuit as claimed in claim 43, if a data sequence which is embedded as said digital watermark data is modulated by a pseudo-random sequence, said integrated circuit further comprising:

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means for obtaining a binary distribution function $F(x)$ which represents a probability that a number x of '1' bits or '0' bits are included in a bit sequence which is read at random from digital data contents, said binary distribution function $F(x)$ being obtained by using a probability q of reading '1' or '0' in said bit sequence and a repeating number of embedding each bit of digital watermark data;

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means for reading an i th digital watermark sequence of said digital watermark data from a digital watermark area of said digital data contents;

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means for demodulating said digital watermark sequence by said pseudo-random sequence;

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bit sequence which is read at random from digital data contents, said binary distribution function $F(x)$ being obtained by using a probability q of reading '1' or '0' in said bit sequence and a

5 repeating number t of embedding each bit of digital watermark data;

means for reading an i th digital watermark sequence of said digital watermark data from a digital watermark area of said digital data

10 contents;

means for demodulating said digital watermark sequence by said pseudo-random sequence;

means for assigning $1/2$ to said probability q ;

15 means for obtaining x_0 or x_1 which satisfies $0 \leq F(x=x_0) \leq 1-\alpha$ or $\alpha \leq F(x=x_1) \leq 1$, α being a threshold of reliability of digital watermark data which is read;

means for determining whether a value is equal to or less than x_0 or equal to or more than x_1 , said value being a mean value of absolute values of a difference between the number of '0' or '1' included in said i th digital watermark sequence and a central value $q \times t$ of a binary distribution;

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25 means for reconstituting digital watermark data by performing majority decision processing for said i th digital watermark sequence if said value is equal to or less than x_0 or equal to or more than x_1 ; and

30 means for determining that there is no digital watermark data or the presence is unknown if said value is not equal to or less than x_0 or equal to or more than x_1 .

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bit sequence which is read at random from digital data contents, said binary distribution function $F(x)$ being obtained by using a probability q of reading '1' or '0' in said bit sequence and a repeating number of embedding each bit of digital watermark data;

means for reading an i th digital watermark sequence of said digital watermark data from a digital watermark area of said digital data contents;

means for demodulating said digital watermark sequence by said pseudo-random sequence;

means for assigning $1/2$ to said probability q ;

means for obtaining a maximum number x_0 which satisfies $0 \leq F(x=x_0) \leq 1-\alpha$ and a minimum number x_1 which satisfies $\alpha \leq F(x=x_1) \leq 1$, α being a threshold of reliability of digital watermark data which is read;

means for obtaining the number k_i of '1' or '0' included in said i th digital watermark sequence; and

means for reconstituting i th digital watermark data w_i as '0' or '1' if $k_i \leq x_0$, and, reconstituting said i th digital watermark data w_i as '1' or '0' if $k_i \geq x_1$.

41. The apparatus as claimed in claim 34, if a data sequence which is embedded as said digital watermark data is modulated by a pseudo-random sequence, said apparatus further comprising:

means for obtaining a binary distribution function $F(x)$ which represents a probability that a number x of '1' bits or '0' bits are included in a

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means for calculating a probability $F(k_1)$ by using said binary distribution function $F(x)$; and

means for reconstituting '1' or '0' from
ith digital watermark data w_i if $F(k_i) > \alpha$,
reconstituting '0' or '1' from ith digital watermark
data w_i if $1-F(k_i) > \alpha$, and, determining that there
is no watermark data or the presence is unknown if
both of $F(k_i) > \alpha$ and $1-F(k_i) > \alpha$ are not satisfied,
 α being a threshold of reliability of digital
watermark data which is read.

which satisfies $\alpha \leq F(x=x_1) \leq 1$;

obtaining the number k_i of '1' or '0' included in said i th digital watermark sequence; and reconstituting i th digital watermark data w_i as '0' or '1' if $k_i \leq x_0$, and reconstituting said i th digital watermark data w_i as '1' or '0' if $k_i \geq x_1$.

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32. The method as claimed in claim 25, if a data sequence which is embedded as said digital watermark data is modulated by a pseudo-random sequence, said method further comprising the steps of:

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determining a threshold α of reliability of digital watermark data which is read;

20

obtaining a binary distribution function $F(x)$ which represents a probability that x of '1' bits or '0' bits are included in a bit sequence which is read at random from digital data contents, said binary distribution function $F(x)$ being obtained by using a probability q of reading '1' or '0' in said bit sequence and a repeating number t of embedding each bit of digital watermark data;

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reading an i th digital watermark sequence of said digital watermark data from a digital watermark area of said digital data contents;

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demodulating said digital watermark

sequence by said pseudo-random sequence;

assigning $1/2$ to said probability q ;

obtaining x_0 or x_1 which satisfies $0 \leq F(x=x_0) \leq 1-\alpha$ or $\alpha \leq F(x=x_1) \leq 1$;

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determining whether a value is equal to or less than x_0 or equal to or more than x_1 , said value being a mean value of absolute values of a difference between the number of '0' or '1' included

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30. The method as claimed in claim 25, if
a data sequence which is embedded as said digital
watermark data is modulated by a pseudo-random
sequence, said method further comprising the steps
5 of:

demodulating said bit sequence by said
pseudo-random sequence; and

reconstituting digital watermark data from
said demodulated bit sequence.

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31. The method as claimed in claim 25, if
15 a data sequence which is embedded as said digital
watermark data is modulated by a pseudo-random
sequence, said method further comprising the steps
of:

20 determining a threshold α of reliability
of digital watermark data which is read;

obtaining a binary distribution function
 $F(x)$ which represents a probability that a number of
 x of '1' bits or '0' bits are included in a bit
sequence which is read at random from digital data
25 contents, said binary distribution function $F(x)$
being obtained by using a probability q of reading
'1' or '0' in said bit sequence and a repeating
number of embedding each bit of digital watermark
data;

30 reading an i th digital watermark sequence
of said digital watermark data from a digital
watermark area of said digital data contents;

demodulating said digital watermark
sequence by said pseudo-random sequence;

35 assigning $1/2$ to said probability q ;

obtaining a maximum number x_0 which
satisfies $0 \leq F(x=x_0) \leq 1-\alpha$ and a minimum number x_1

transform;

program code means for obtaining
difference values between said first frequency
coefficients and said second frequency coefficients
5 for each frequency coefficient;

program code means for calculating a
standard deviation of distribution of said
difference values; and

program code means for obtaining said
10 quantization width by multiplying said standard
deviation by a watermark embedding strength.

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25. A method for reading digital watermark
data embedded in digital data contents, said method
comprising the steps of:

receiving said digital data contents;
20 reading a bit sequence from said digital
data contents;
calculating a probability of reading a bit
'1' or a bit '0' in said bit sequence by using a
test method on the basis of binary distribution;
25 determining the presence or absence of
digital watermark data according to said
probability; and

reconstituting and generating said digital
watermark data from said bit sequence.

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26. The method as claimed in claim 25,
35 further comprising the steps of:

determining threshold α of reliability of
digital watermark data which is read;

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23. A computer readable medium storing
program code for causing a computer system to read
digital watermark data embedded in digital data
5 contents, said computer readable medium comprising:

program code means for receiving said
digital data contents;

program code means for dividing said
digital data contents into block data;

10 program code means for obtaining a
frequency coefficient of said block data; and

program code means for generating digital
watermark data from said frequency coefficient by
using a quantization width corresponding to said
15 frequency coefficient, said quantization width being
obtained beforehand according to a manipulation
method of said digital data contents.

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24. The computer readable medium as
claimed in claim 23, wherein said quantization width
is obtained by program code means comprising:

25 program code means for dividing first
digital data contents into one or a plurality of
first block data;

program code means for dividing second
digital data contents into one or a plurality of
30 second block data, said second digital data contents
being obtained by manipulating said first digital
data contents with a predetermined manipulation
method;

program code means for transforming said
35 first block data and said second block data into
first frequency coefficients and second frequency
coefficients respectively by applying an orthogonal

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program code means for generating watermarked digital data contents.

22. The computer readable medium as claimed in claim 21, wherein said quantization width is obtained by program code means comprising:

15 program code means for dividing second
digital data contents into one or a plurality of
second block data, said second digital data contents
being obtained by manipulating said first digital
data contents with a predetermined manipulation
method;

25 program code means for obtaining
difference values between said first frequency
coefficients and said second frequency coefficients
for each frequency coefficient;

program code means for obtaining said quantization width by multiplying said standard deviation by a watermark embedding strength.

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high frequency coefficients exceeding a threshold.

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3. A method for embedding digital watermark data in digital data contents, said method comprising the steps of:

receiving said digital data contents and
10 said digital watermark data;

dividing said digital data contents into block data;

obtaining a frequency coefficient of said block data;

15 obtaining an amount of transformation of said frequency coefficient from said digital watermark data by using a quantization width corresponding to said frequency coefficient, said quantization width being obtained beforehand
20 according to a manipulation method of said digital data contents;

embedding said digital watermark data in said digital data contents by transforming said frequency coefficient by said amount; and

25 generating watermarked digital data contents.

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4. The method as claimed in claim 3, wherein said quantization width is obtained by a method comprising the steps of:

dividing first digital data contents into
35 one or a plurality of first block data;

dividing second digital data contents into one or a plurality of second block data, said second

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digital data contents being obtained by manipulating said first digital data contents with a predetermined manipulation method;

transforming said first block data and
5 said second block data into first frequency coefficients and second frequency coefficients respectively by applying an orthogonal transform;

obtaining difference values between said first frequency coefficients and said second
10 frequency coefficients for each frequency coefficient;

calculating a standard deviation of distribution of said difference values; and

obtaining said quantization width by
15 multiplying said standard deviation by a watermark embedding strength.

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5. A method for reading digital watermark data embedded in digital data contents, said method comprising the steps of:

receiving said digital data contents;

25 dividing said digital data contents into block data;

obtaining a frequency coefficient of said block data; and

generating digital watermark data from
30 said frequency coefficient by using a quantization width corresponding to said frequency coefficient, said quantization width being obtained beforehand according to a manipulation method of said digital data contents.

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6. The method as claimed in claim 5, wherein said quantization width is obtained by a method comprising the steps of:

- 5 dividing first digital data contents into one or a plurality of first block data;
 dividing second digital data contents into one or a plurality of second block data, said second digital data contents being obtained by manipulating
10 said first digital data contents with a predetermined manipulation method;
 transforming said first block data and said second block data into first frequency coefficients and second frequency coefficients
15 respectively by applying an orthogonal transform;
 obtaining difference values between said first frequency coefficients and said second frequency coefficients for each frequency coefficient;
20 calculating a standard deviation of distribution of said difference values; and
 obtaining said quantization width by multiplying said standard deviation by a watermark embedding strength.
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7. An apparatus for embedding digital
30 watermark data in digital data contents, said apparatus comprising:
 means for receiving said digital data contents and said digital watermark data;
 means for dividing said digital data
35 contents into block data;
 means for obtaining a frequency coefficient of said block data;

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means for obtaining an amount of transformation of said frequency coefficient from said complexity and said digital watermark data by using a quantization width;

10 means for generating watermarked digital
data contents.

means for transforming said block data, by
20 applying a wavelet transform, into coefficients of
said wavelet transform, and

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9. An apparatus for embedding digital watermark data in digital data contents, said apparatus comprising:

means for dividing said digital data
contents into block data;

means for obtaining a frequency coefficient of said block data;

means for obtaining an amount of transformation of said frequency coefficient from
5 said digital watermark data by using a quantization width corresponding to said frequency coefficient, said quantization width being obtained beforehand according to a manipulation method of said digital data contents;

10 means for embedding said digital watermark data in said digital data contents by transforming said frequency coefficient by said amount; and

means for generating watermarked digital data contents.

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20 10. The apparatus as claimed in claim 9, wherein said quantization width is obtained by means comprising:

means for dividing first digital data contents into one or a plurality of first block data;

25 means for dividing second digital data contents into one or a plurality of second block data, said second digital data contents being obtained by manipulating said first digital data contents with a predetermined manipulation method;

30 means for transforming said first block data and said second block data into first frequency coefficients and second frequency coefficients respectively by applying an orthogonal transform;

35 means for obtaining difference values between said first frequency coefficients and said second frequency coefficients for each frequency coefficient;

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means for obtaining said quantization width by multiplying said standard deviation by a watermark embedding strength.

means for receiving said digital data contents;

means for obtaining a frequency
coefficient of said block data; and

means for generating digital watermark data from said frequency coefficient by using a quantization width corresponding to said frequency coefficient, said quantization width being obtained beforehand according to a manipulation method of said digital data contents.

means for dividing first digital data contents into one or a plurality of first block data;

means for dividing second digital data contents into one or a plurality of second block data, said second digital data contents being

means for transforming said first block
data and said second block data into first frequency
5 coefficients and second frequency coefficients
respectively by applying an orthogonal transform;

means for calculating a standard deviation of distribution of said difference values; and

20 13. An integrated circuit for embedding
digital watermark data in digital data contents,
said integrated circuit comprising:

25 means for dividing said digital data
contents into block data;

means for obtaining a complexity of said
30 block data;

35 means for embedding said digital watermark data in said digital data contents by transforming said frequency coefficient by said amount; and

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means for obtaining an amount of transformation of said frequency coefficient from said digital watermark data by using a quantization width corresponding to said frequency coefficient, said quantization width being obtained beforehand according to a manipulation method of said digital data contents;

means for embedding said digital watermark data in said digital data contents by transforming said frequency coefficient by said amount; and

5 means for generating watermarked digital data contents.

10 16. The integrated circuit as claimed in claim 15, wherein said quantization width is obtained by means comprising:

15 means for dividing first digital data contents into one or a plurality of first block data;

means for dividing second digital data contents into one or a plurality of second block data, said second digital data contents being obtained by manipulating said first digital data contents with a predetermined manipulation method;

20 means for transforming said first block data and said second block data into first frequency coefficients and second frequency coefficients respectively by applying an orthogonal transform;

25 means for obtaining difference values between said first frequency coefficients and said second frequency coefficients for each frequency coefficient;

30 means for calculating a standard deviation of distribution of said difference values; and

means for obtaining said quantization width by multiplying said standard deviation by a watermark embedding strength.

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17. An integrated circuit for reading digital watermark data embedded in digital data contents, said integrated circuit comprising:

5 means for receiving said digital data contents;

means for dividing said digital data contents into block data;

means for obtaining a frequency coefficient of said block data; and

10 means for generating digital watermark data from said frequency coefficient by using a quantization width corresponding to said frequency coefficient, said quantization width being obtained beforehand according to a manipulation method of
15 said digital data contents.

20 18. The integrated circuit as claimed in claim 17, wherein said quantization width is obtained by means comprising:

25 means for dividing first digital data contents into one or a plurality of first block data;

30 means for dividing second digital data contents into one or a plurality of second block data, said second digital data contents being obtained by manipulating said first digital data contents with a predetermined manipulation method;

means for transforming said first block data and said second block data into first frequency coefficients and second frequency coefficients respectively by applying an orthogonal transform;

35 means for obtaining difference values between said first frequency coefficients and said second frequency coefficients for each frequency

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coefficient;

means for calculating a standard deviation of distribution of said difference values; and

means for obtaining said quantization width by multiplying said standard deviation by a watermark embedding strength.

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19. A computer readable medium storing program code for causing a computer system to embed digital watermark data in digital data contents, said computer readable medium comprising:

15 program code means for receiving said digital data contents and said digital watermark data;

program code means for dividing said digital data contents into block data;

20 program code means for obtaining a frequency coefficient of said block data;

program code means for obtaining a complexity of said block data;

25 program code means for obtaining an amount of transformation of said frequency coefficient from said complexity and said digital watermark data by using a quantization width;

30 program code means for embedding said digital watermark data in said digital data contents by transforming said frequency coefficient by said amount; and

program code means for generating watermarked digital data contents.

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5 program code means for transforming said
block data, by applying a wavelet transform, into
coefficients of said wavelet transform, and

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program code means for obtaining a frequency coefficient of said block data;

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61. A method for reading digital watermark
5 data from digital data contents in which each bit of
digital watermark data is embedded a plurality of
times, said method comprising the steps of:
receiving digital data contents;
reading a digital watermark sequence from
10 said digital data contents;
performing soft decision in code theory by
assigning weights to said digital watermark sequence
with a weighting function; and
reconstituting and generating digital
15 watermark data from said digital watermark sequence.

62. The method as claimed in claim 61,
20 wherein said weighting function is a distribution
function obtained by a method comprising the steps
of:
dividing first digital data contents into
25 one or a plurality of first block data;
dividing second digital data contents into
one or a plurality of second block data, said second
digital data contents being obtained by manipulating
said first digital data contents with a
30 predetermined manipulation method;
transforming said first block data and
said second block data into first frequency
coefficients and second frequency coefficients
respectively by applying an orthogonal transform;
35 and
obtaining a distribution of difference
values between said first frequency coefficients and

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said second frequency coefficients, said distribution function being an approximation of said distribution,

5 wherein said weights are assigned to said digital watermark sequence according to values of said distribution function.

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63. The method as claimed in claim 61, wherein said weighting function is a distribution function obtained by a method comprising the steps of:

15 dividing first digital data contents into one or a plurality of first block data;

dividing second digital data contents into one or a plurality of second block data, said second digital data contents being obtained by manipulating
20 said first digital data contents with a predetermined manipulation method;

transforming said first block data and said second block data into first frequency coefficients and second frequency coefficients
25 respectively by applying an orthogonal transform; and

obtaining said distribution function on the basis of a theory if a distribution of difference values between said first frequency
30 coefficients and said second frequency coefficients can be obtained by said theory,

wherein said weights are assigned to said digital watermark sequence according to values of said distribution function.

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said distribution function being an approximation of said distribution.

wherein said weights are assigned to said digital watermark sequence according to values of said distribution function.

66. The apparatus as claimed in claim 64, wherein said weighting function is a distribution function obtained by means comprising:

means for dividing first digital data contents into one or a plurality of first block data;

means for dividing second digital data contents into one or a plurality of second block data, said second digital data contents being obtained by manipulating said first digital data contents with a predetermined manipulation method;

means for transforming said first block data and said second block data into first frequency coefficients and second frequency coefficients respectively by applying an orthogonal transform ;

means for obtaining said distribution function on the basis of a theory if a distribution of difference values between said first frequency coefficients and said second frequency coefficients can be obtained by said theory, and

wherein said weights are assigned to said digital watermark sequence according to values of said distribution function.

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67. An integrated circuit for reading

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- means for dividing second digital data contents into one or a plurality of second block data, said second digital data contents being obtained by manipulating said first digital data contents with a predetermined manipulation method;
- means for transforming said first block data and said second block data into first frequency coefficients and second frequency coefficients respectively by applying an orthogonal transform; and
- means for obtaining a distribution of difference values between said first frequency coefficients and said second frequency coefficients, said distribution function being an approximation of

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70. A computer readable medium storing

program code for causing a computer system to read digital watermark data from digital data contents in which each bit of digital watermark data is embedded a plurality of times, said computer readable medium comprising:

program code means for receiving digital data contents;

program code means for reading a digital watermark sequence from said digital data contents;

program code means for performing soft decision in code theory by assigning weights to said digital watermark sequence with a weighting function; and

program code means for reconstituting and generating digital watermark data from said digital watermark sequence.

71. The computer readable medium as claimed in claim 70, wherein said weighting function is a distribution function obtained by program code means comprising:

program code means for dividing first digital data contents into one or a plurality of first block data;

program code means for dividing second digital data contents into one or a plurality of second block data, said second digital data contents being obtained by manipulating said first digital data contents with a predetermined manipulation method;

program code means for transforming said first block data and said second block data into first frequency coefficients and second frequency coefficients respectively by applying an orthogonal

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program code means for obtaining a distribution of difference values between said first frequency coefficients and said second frequency coefficients, said distribution function being an approximation of said distribution,

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program code means for dividing first
digital data contents into one or a plurality of
20 first block data;

program code means for transforming said first block data and said second block data into first frequency coefficients and second frequency coefficients respectively by applying an orthogonal transform; and

wherein said weights are assigned to said

digital watermark sequence according to values of
said distribution function.

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